



# Performance Matters More Than MHz

AMD Press Presentation

October 2001

# Agenda



- ❑ A new strategy
- ❑ The world's highest performance PC processor

# Defining Performance



- ❑ Performance is determined by:

*IPC (work per clock cycle) x MHz (clock speed)*

- ❑ In the 286, 386, and 486 processor generations, the underlying architecture from AMD and Intel was the same.
  - IPC was essentially constant
  - Performance was reasonably represented by MHz
- ❑ Starting with the fifth-generation x86 processors, AMD and Intel diverged on the underlying architectures.
- ❑ IPC became an important part of the performance equation.

# Intel's View of Performance



## What Determines True Processor Performance?

The only measure of performance that really matters is the amount of time it takes to execute a given application. Contrary to a popular misconception, it is not clock frequency (MHz) alone or the number of instructions executed per clock (IPC) alone that equates to performance. True performance is a combination of both clock frequency (MHz) and IPC:

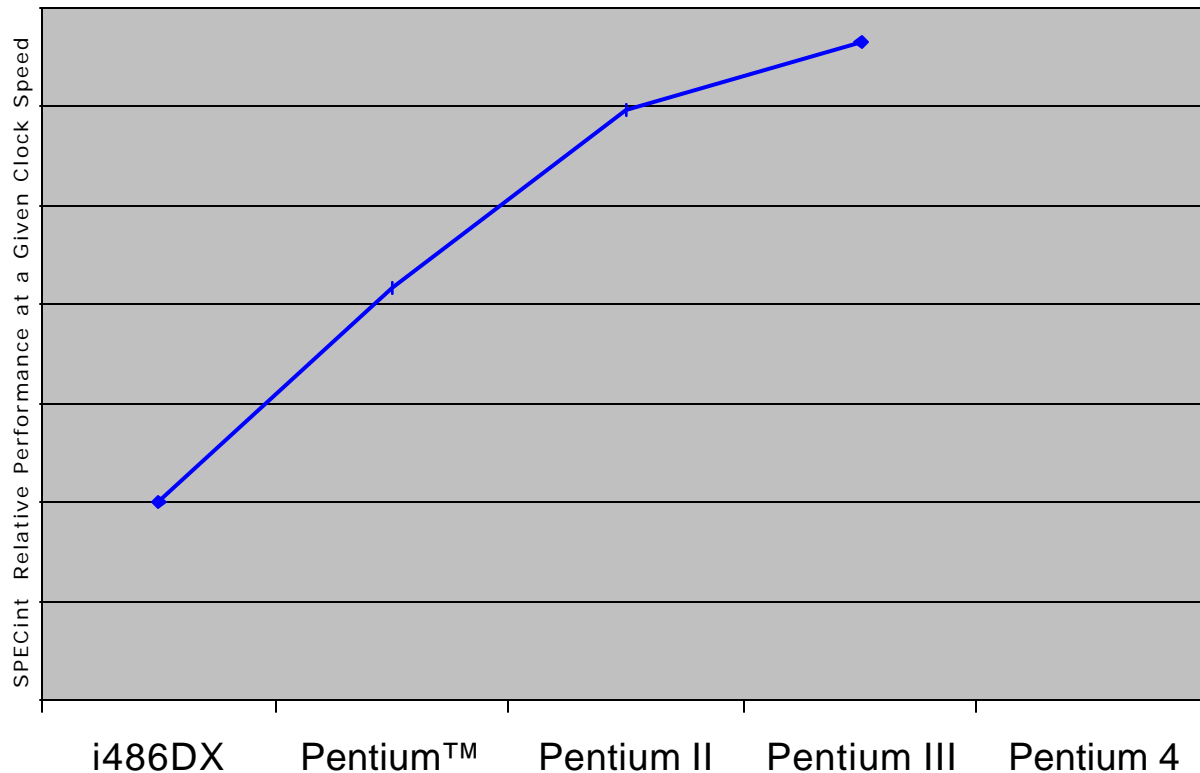
$$\text{Performance} = \text{MHz} \times \text{IPC}$$

This shows that the performance can be improved by increasing frequency, IPC or optimally both. It turns out that frequency is a function of both the manufacturing process and the micro-architecture. At a given clock frequency, the IPC is a function of processor micro-architecture and the specific application being executed. Although it is not always feasible to improve both the frequency and the IPC, increasing one and holding the other close to constant with the prior generation can still achieve a significantly higher level of performance.

"Inside the NetBurst™ Micro-Architecture of the Intel® Pentium® 4 Processor, revision 1.0", Intel Corp., Nov 2000

**"The trade-off between instructions per cycle and the increasing emphasis on microprocessor clock frequency needs a thorough re-examination. My point is that it is not so much one against the other. We need both [instructions per cycle and frequency], and it is a real delicate balancing act. The question I am raising is, in what new and clever ways can we combine the two?"—John Shen, director of Intel Corporation's microarchitecture lab, speaking at ICCD, September 2001.**

# Historical Work Per Clock



The **expectation** has been set that **work per clock and frequency increase** with each progressive processor generation

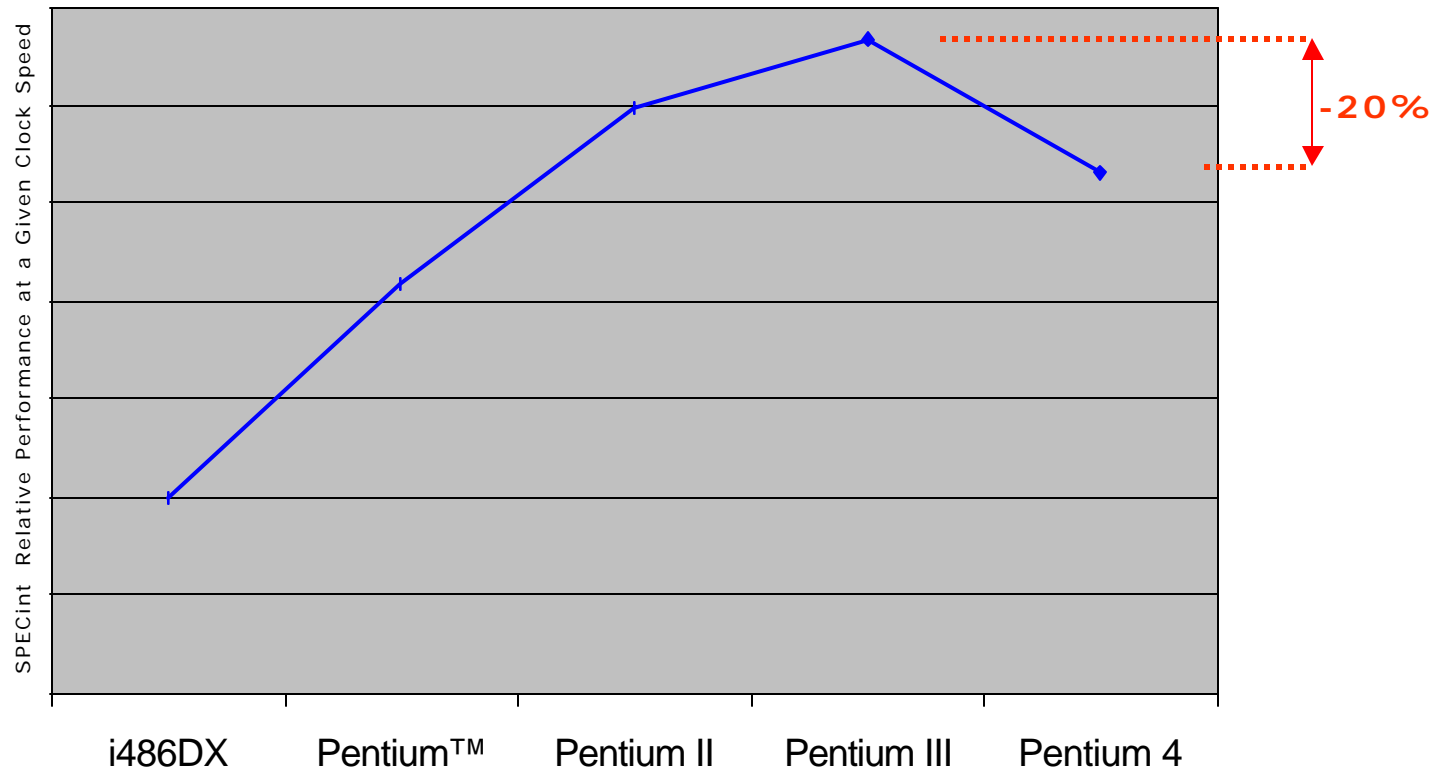
# Current Work Per Clock



What Intel says about Pentium® 4 architecture:

...“this design effort [Pentium 4] focused on delivering an average instruction executed per clock (IPC) that was within approximately 10% to 20% of the P6 micro-architecture...”

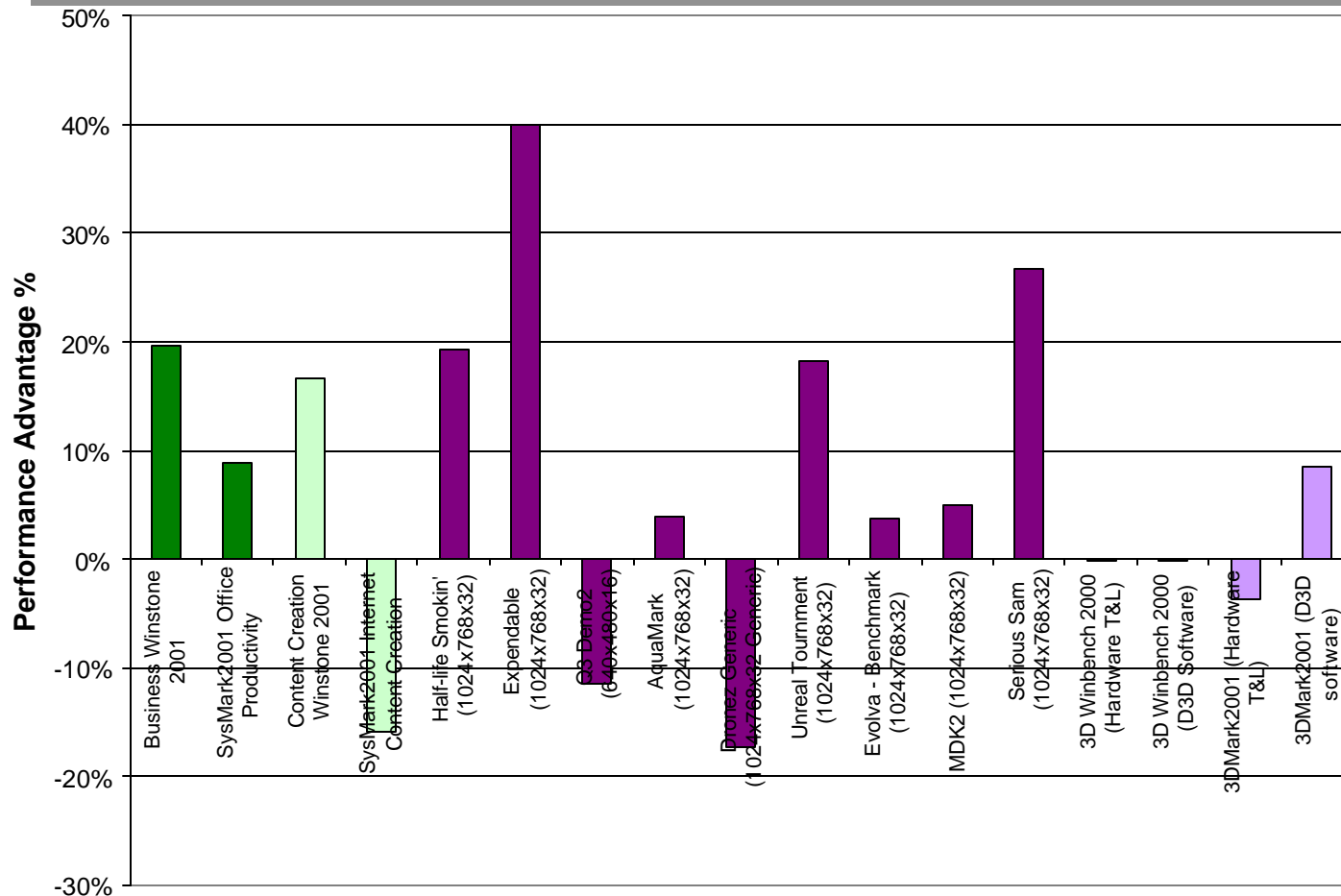
-“Desktop Performance and Optimization for Pentium® 4 Processor”– Intel Corp., Feb 2001



# The MHz Myth



AMD Athlon™ 1.4GHz vs. Intel® Pentium® 4 1.7GHz  
Windows® XP



The Pentium® 4 is propagating the **"MHz Myth"**:

- MHz is devalued as a measure of system performance.

# The Expectation



- ❑ New x86 microprocessors have historically improved work per clock and frequency compared to older generations
- ❑ Pentium 4 broke this paradigm
  - Frequency goes up
  - Work per clock goes down
- ❑ End users who rely on MHz as an indication of relative performance are the victims of this missed expectation
  - Pentium 4's focus on MHz appeals to what end users naively believe is an indication of relative performance



# Other Markets Focus on Application Performance



- ❑ The world's most powerful workstations & servers all have low frequency (MHz) processors
  - Compaq Alpha<sup>®</sup> – 1001MHz
  - IBM RS/6000 – 450MHz
  - HP PA8600 “SuperDome” – 550MHz
  - Intel's own top-of-the-line Itanium processors only reach frequencies of 733 and 800MHz
  
- ❑ PDAs
  - Evaluated and purchased on application performance & features, not frequency

# Implication



- Customers can no longer rely on MHz as the only indicator of real application performance for different processors.
- The end user needs a more accurate measure of software performance than simply a processor's frequency (MHz/GHz).

# True Performance Initiative



- ❑ AMD plans to drive the True Performance Initiative (TPI)—a strategic initiative with industry leaders to assist end users in understanding the benefits of PC performance. TPI also will help define a new, more accurate measure of processor performance.
- ❑ Through this initiative, AMD is working to educate end users about the benefits of PC performance:
  - Inform end users of the “MHz Myth” that exists.
  - Develop a reliable processor performance metric that end users can trust.
- ❑ The True Performance Initiative reflects AMD’s commitment to business and home PC users.



# **World's Highest-Performance Processor**

October 2001

# AMD Athlon™ XP Processor with QuantiSpeed™ architecture



- ❑ AMD is adding four new high-performance microprocessors to its AMD Athlon™ family in October.
- ❑ Processors are planned to ship in volume prior to introduction
- ❑ Broad infrastructure support
- ❑ Availability anticipated from multiple OEMs
- ❑ Channel availability expected at direct, retail and system builders worldwide



# AMD Athlon™ XP Processor Branding & Naming



- ❑ AMD's high performance desktop processor based on the "Palomino" core will be named the AMD Athlon™ XP processor.
- ❑ The new "XP" modifier signifies that the architectural enhancements in the "Palomino" processor core deliver "extreme performance for Windows® XP"
  - vs. existing AMD microprocessors
  - vs. competitive PC microprocessors



# AMD Athlon™ XP Processor

## The Ultimate Experience



- ❑ Provides a quick, effortless computing experience with no hassle.
  - Boots and loads applications quickly
  - Boosts overall productivity
  - Offers rapid results when working with digital media like audio, video, and image files
  - Transforms digital media files into the desired format in a short amount of time
  - Renders complex 3D images quickly
- ❑ Designed to run flawlessly on the world's most popular software
- ❑ Has the extreme performance essential to the ultimate Windows® XP computing experience
  - Brings digital entertainment like games and DVDs to life with richer, smoother graphics and true to life sound
  - Delivers a phenomenal Internet experience with smoother streaming audio and video
  - Provides outstanding real-time voice, video, and text messaging
  - Takes advantage of connected digital devices and their content by delivering more realistic photos, smoother videos, and richer sound

# AMD Athlon™ XP Processor

## Next-Generation Features



		AMD Athlon™ Processor	AMD Athlon XP Processor
Technical Specs	Infrastructure	Socket A	Socket A
	Process Technology	0.18 micron	0.18 micron
	# of Transistors (die size)	37 million (120 mm <sup>2</sup> )	<b>37.5 million (128 mm<sup>2</sup>)</b>
	Relative Power	--	<b>~20% reduction</b>
	Enhanced Thermal Control Features	No	<b>Thermal diode</b>
Key Features			
	QuantiSpeed™ Architecture	No	<b>Yes</b>
	High-Performance Full Speed Cache	384k total	384k total
	Advanced Front-Side Bus	200MHz & 266 MHz	<b>266MHz</b>
	3D and Multimedia Instructions	Enhanced 3DNow!™ technology	<b>3DNow! Professional technology</b> (adds 52 new instructions)



# QuantiSpeed™ architecture

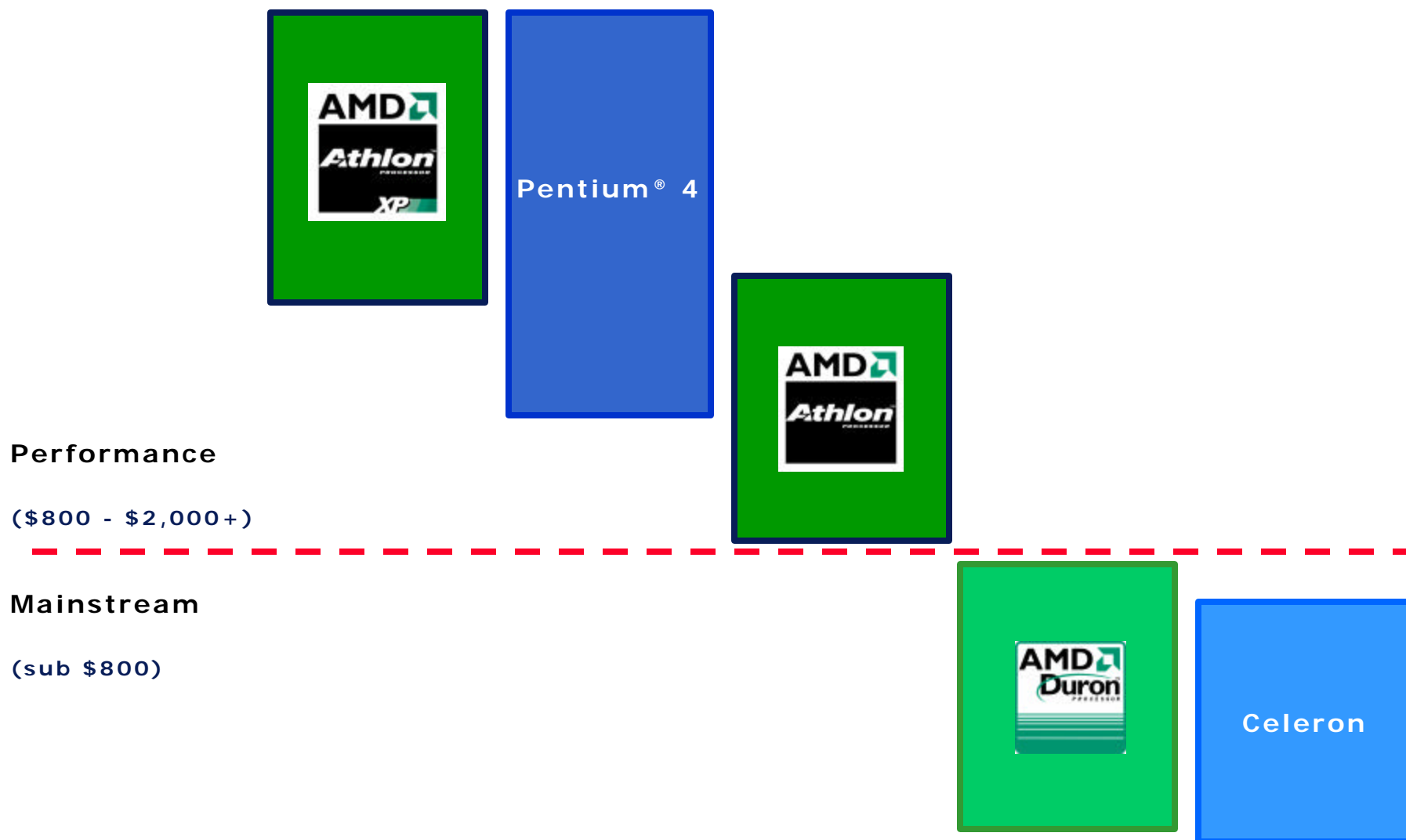


- ❑ An easy-to-understand name which encompasses the AMD Athlon™ XP processor's core architectural features
- ❑ QuantiSpeed architecture incorporates:
  - 9 issue, fully pipelined, superscalar micro-architecture
  - Superscalar, fully pipelined Floating Point Unit (FPU)
  - Hardware data pre-fetch
  - Exclusive & speculative Translation Look-aside Buffers (TLB)
- ❑ Explains to end users how the AMD Athlon XP processor provides superior overall application performance

# AMD Athlon™ XP Processor Positioning



## Desktop Market Segments by Price Point



# AMD Athlon™ XP Processor Model Numbering



- ❑ AMD Athlon™ XP processors will be sold on the basis of relative performance.
- ❑ Model numbers convey relative application performance among the various AMD Athlon XP processors, as well as communicate the architectural superiority over existing AMD Athlon processors.
- ❑ Delivers system performance superiority in head-to-head competitive comparisons

AMD Athlon™ XP processor	
Model Number	Operating Frequency
1800+	1.53 GHz
1700+	1.47 GHz
1600+	1.40 GHz
1500+	1.33 GHz

# AMD Athlon™ XP Processor Positioning

## Based on Application Benchmarks



- ❑ Benchmarking is the cornerstone of the AMD Athlon™ XP processor performance positioning.
- ❑ Performance positioning based on multiple applications types:
  - Digital Media, Office Productivity & 3D Gaming
- ❑ Based on a broad array of industry standard benchmarks
- ❑ Andersen is independently examining the AMD Athlon XP processor performance benchmarks.

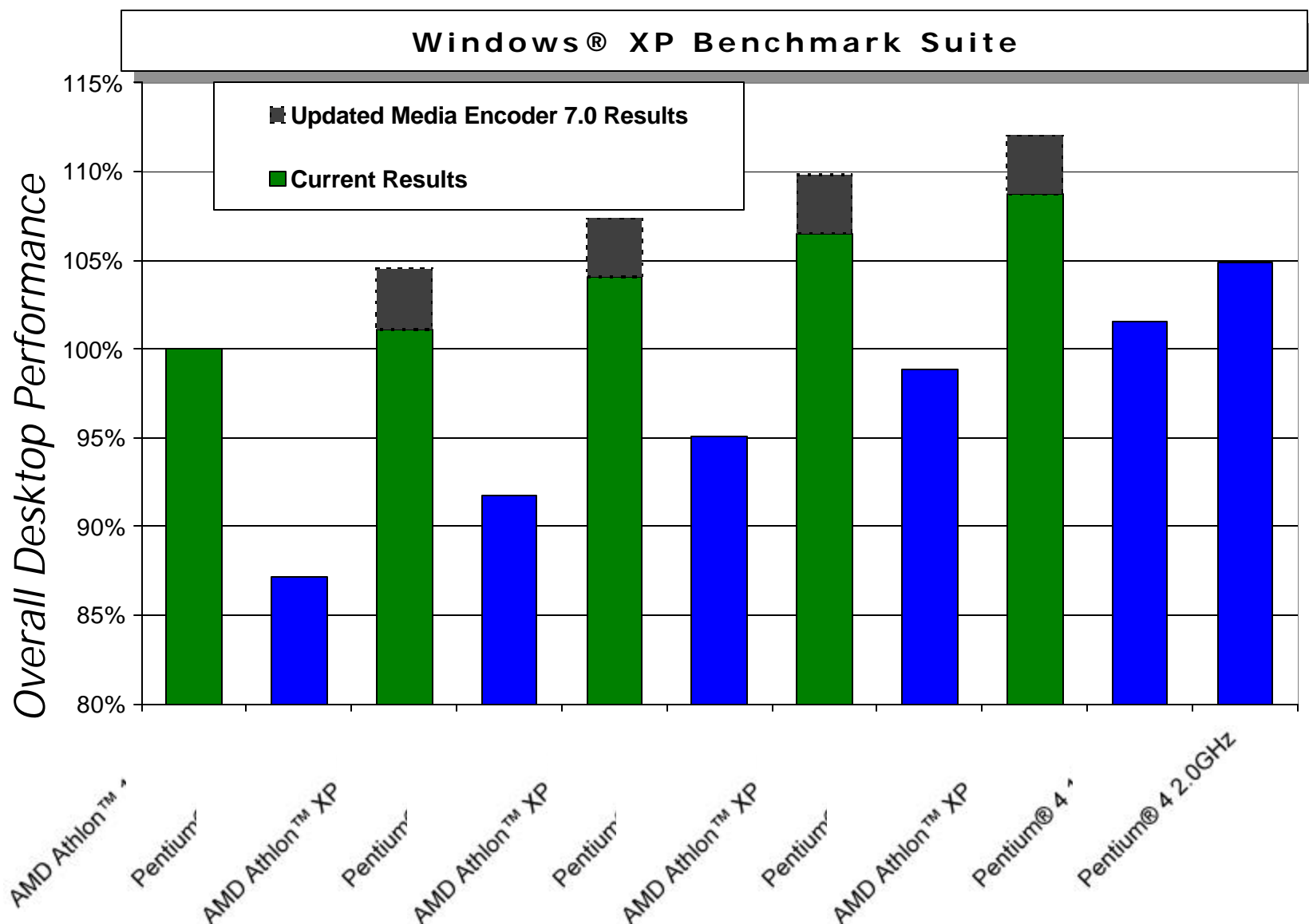
# Performance Positioning Independently Audited



- ❑ Arthur Andersen is independently examining the AMD Athlon™ XP processor performance benchmarks.
- ❑ Andersen will audit the AMD Athlon™ XP processor results. This examination will include independent observation and tests of the system configuration, benchmark procedures and the recording of results.
- ❑ A full report detailing the results of the auditing process will be available on the AMD Web site.
- ❑ AMD will reference the Andersen auditing of our benchmark results in press and marketing collateral.



# Relative Performance



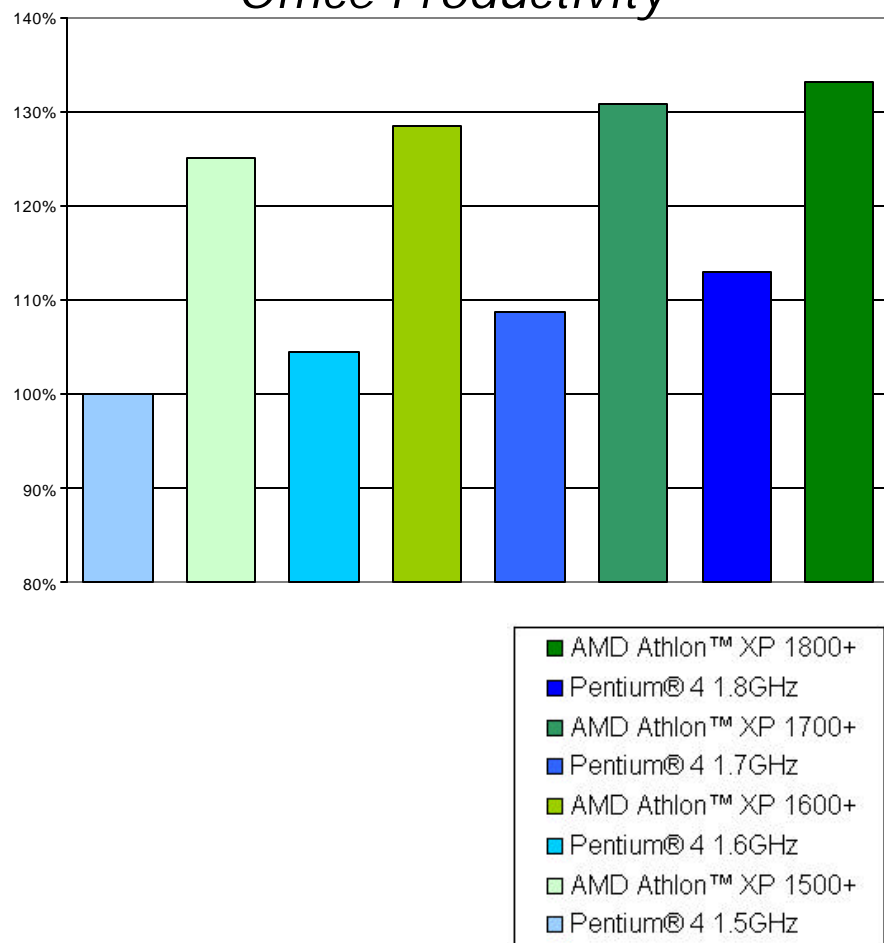
Updated Windows(R) Media Encoder Results contain a software update which enables 3DNow! Professional technology in version 7.0 of Microsoft Windows® Media Encoder. This software patch is not publicly available; however subsequent versions of Microsoft Windows Media Encoder are planned to enable support for 3DNow! Professional technology

# AMD Athlon™ XP Processor Application Performance

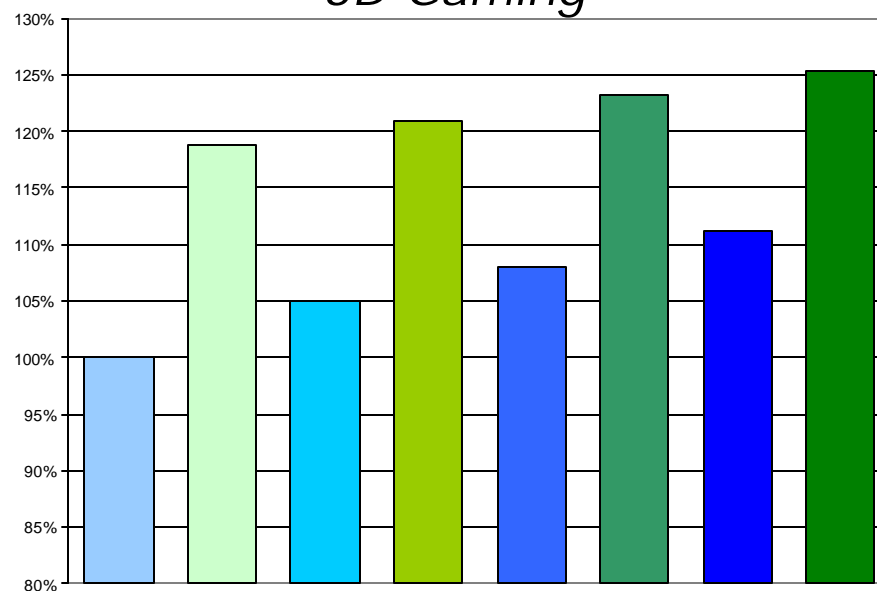


Average performance of AMD Athlon™ XP and Pentium® 4 processors running Windows® XP

## Office Productivity



## 3D Gaming



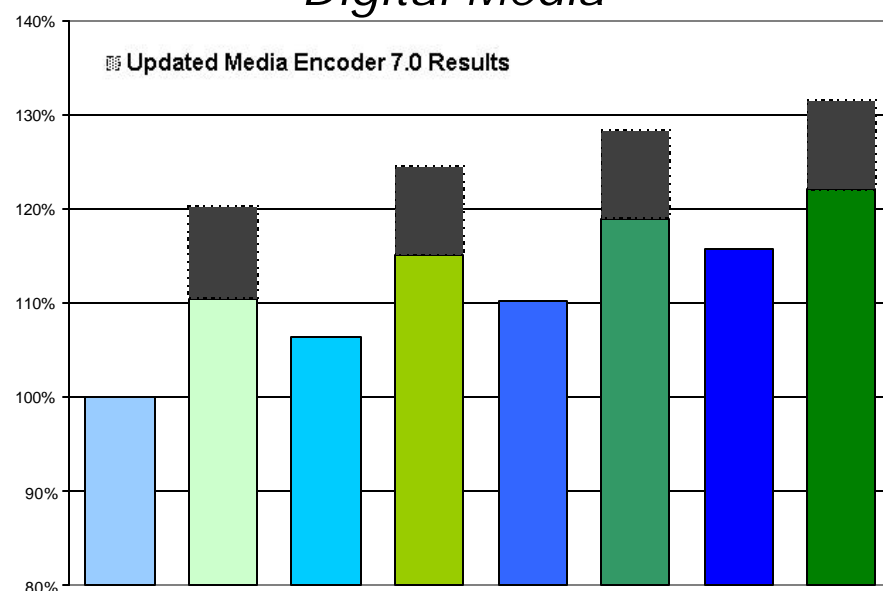
(see backup for benchmark and configuration details) 23

# AMD Athlon™ XP Processor Application Performance

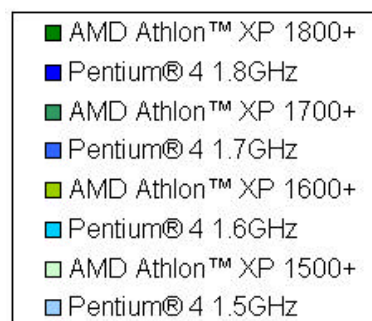


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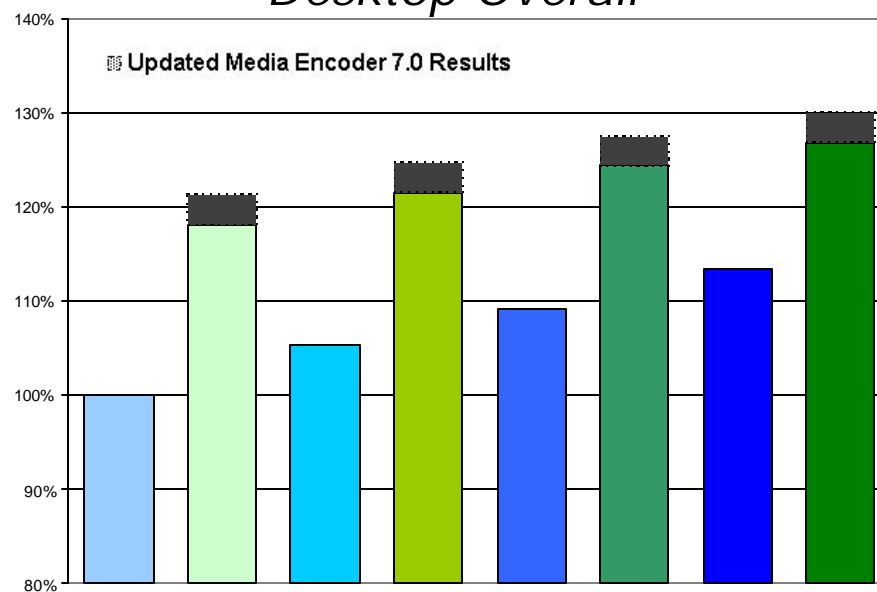
## Digital Media



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## Desktop Overall



(see backup for benchmark and configuration details) 24

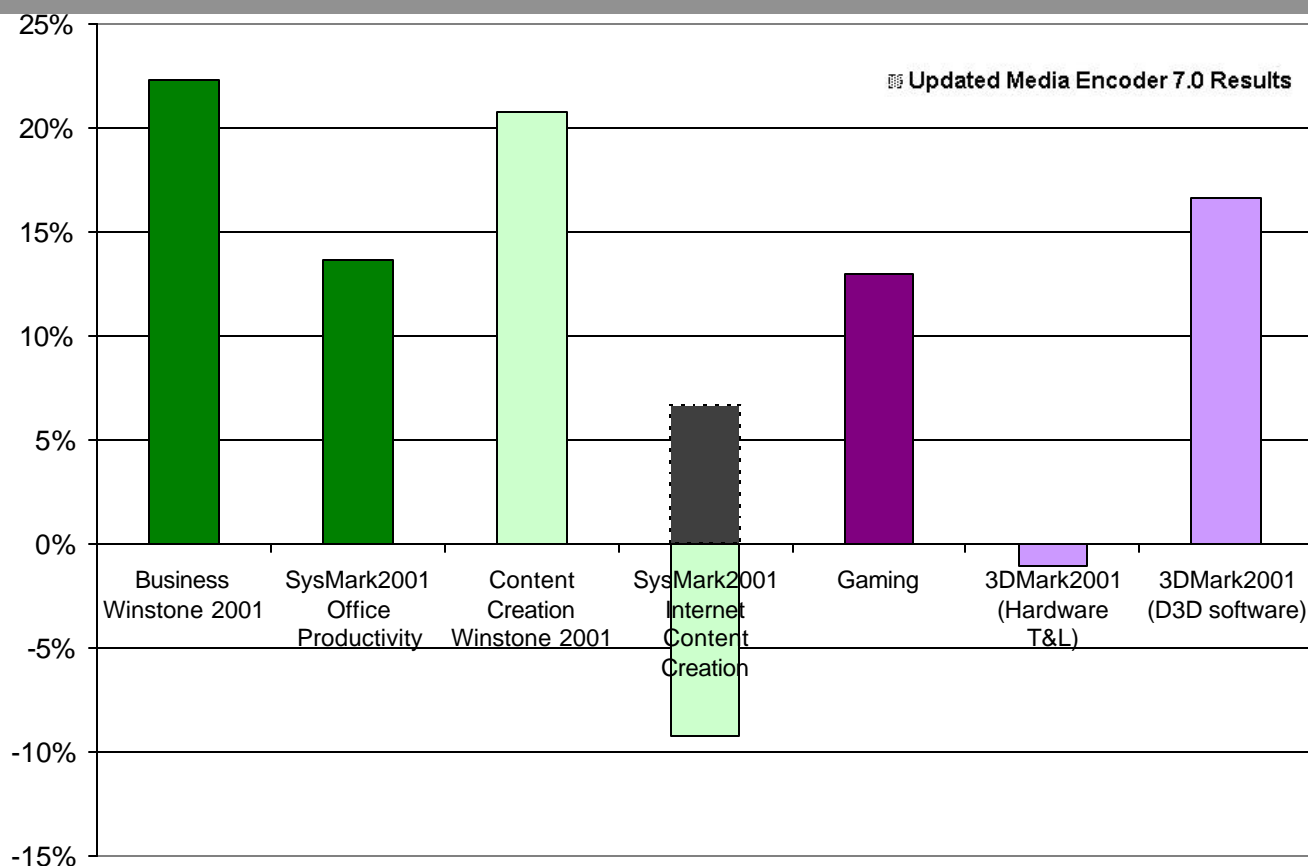


# AMD Athlon™ XP Processor

## Application Performance



AMD Athlon™ XP 1800+ vs. Intel® Pentium® 4 1.8GHz  
Windows® XP



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More information on 'gaming' suite and configuration information in backup

# Performance Positioning

## Usage Example—Consumer/Retail



### Sample Shelf Tag

**ABC Computer**

Model 040970

**AMD ATHLON™ XP PROCESSOR 1800+**

**\$1,599**

- QuantiSpeed™ architecture\* outperforms competitive 1.8GHz PC processors
- 256 MB PC2100 DDR SDRAM
- 80.0 GB UltraDMA HDD, DVD-ROM, CD-RW
- 266 MHz system bus
- Nvidia GeForce2 with 32MB video memory
- Creative Sound Blaster Live! Sound card

\* QuantiSpeed architecture operates at 1.5GHz

Height: 17.4" Width: 7.1" Depth: 16.25"

**Service Plan**

**\$199.99**

# Product Availability & Support



## ❑ OEM Systems

- Availability planned from Best Buy and multiple OEMs worldwide, including Compaq, Micron, NEC-CI, Fujitsu, and Fujitsu-Siemens

## ❑ Channels

- Retail
- Direct
- System Builders

## ❑ Broad chipset support



## ❑ Motherboards

- DDR-based motherboards from multiple motherboard manufacturers are available or in development.

# Summary



- ❑ New x86 microprocessors have historically improved work per clock and frequency over older ones—Pentium® 4 missed that expectation
- ❑ AMD plans to drive an industry-wide initiative—True Performance Initiative—to develop a new and more complete measure of processor performance that end users can trust.
- ❑ AMD is adding four brand new high-performance microprocessors with its new AMD Athlon™ XP processor launch in October.
- ❑ Immediate availability from Compaq, NEC-Cl, Best Buy, and across a variety of channels, is expected at introduction. Micron, Fujitsu-Siemens and Fujitsu are also expected to offer systems later this month.



# Backup

# AMD Athlon™ XP Processor



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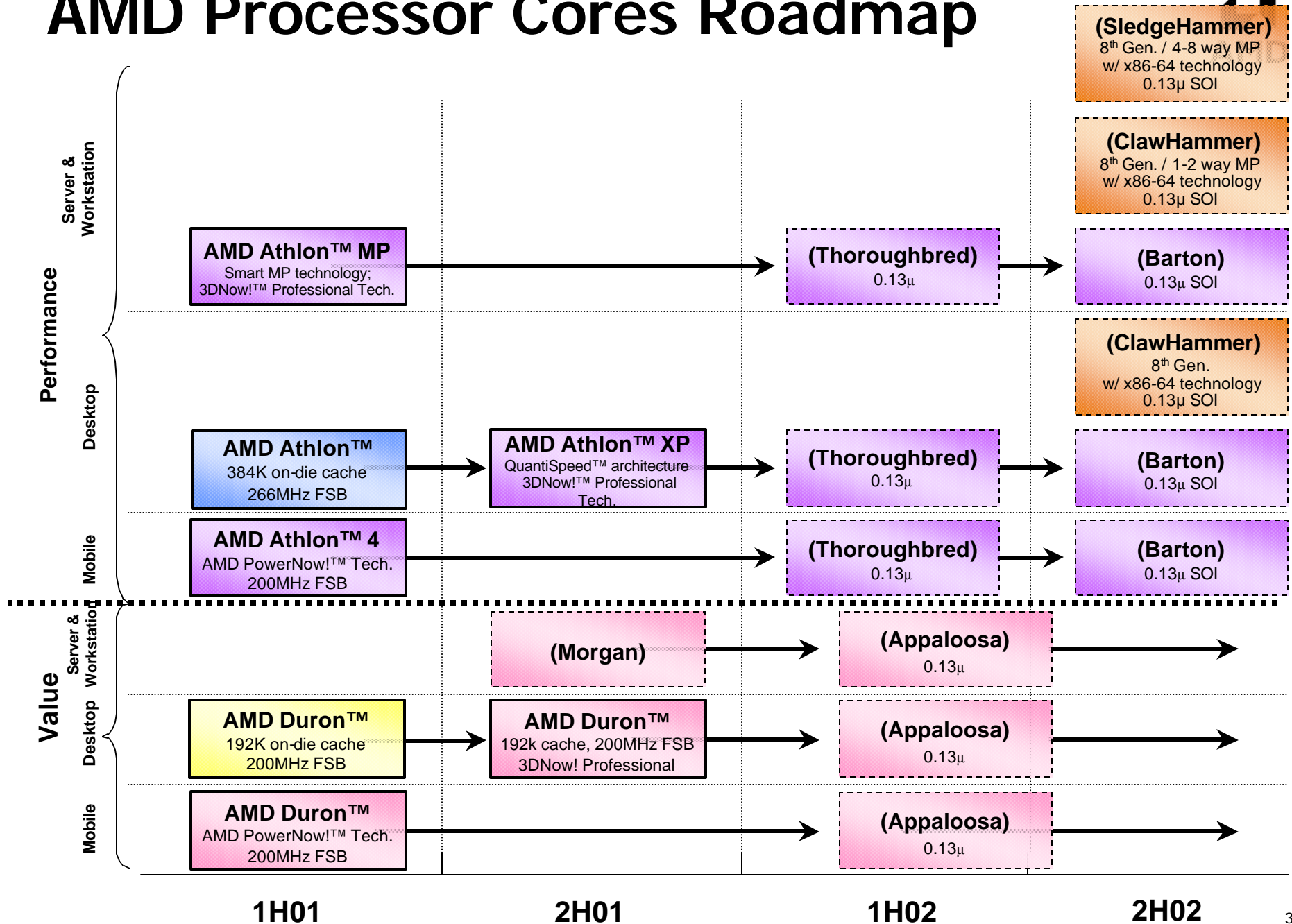
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# AMD Processor Cores Roadmap



# AMD Recent Success Stories



## ❑ **PCWorld October 2001**

- All 5 of the 5 "Power Systems" are AMD systems
- 6 of the 10 "Value Systems" are AMD systems

## ❑ **Maximum PC October 4, 2001**

- 2 of the 3 "Desktop Systems Top Picks" are AMD systems

## ❑ **ZDNet October 4, 2001**

- 4 of the "Top 5 Gaming and Multimedia Systems" are AMD systems
- 3 of the "Top 5 Fast PCs" are AMD systems
- 3 of the "Top 5 Well-designed Systems" are AMD systems
- 4 of the "Top 5 Value Systems" are AMD systems



# Benchmarking Approach



- ❑ AMD uses a broad array of industry standard benchmarks from three categories: office productivity, digital media and 3D gaming
- ❑ Equal weighting to the 3 benchmark categories
- ❑ Equal weighting to the benchmarks within a category
- ❑ 14 benchmarks covering 34 applications were included
- ❑ Normalized results
  - Benchmark results are normalized to demonstrate head-to-head competitive comparisons
    - For example, the AMD Athlon™ XP processor 1800+ results are normalized to the 1.8GHz Pentium® 4 processor results

# Benchmark Suites



## ❑ Desktop Overall

- Equally weighted average of all benchmark categories
  - *Benchmarks within each category are weighted to ensure that each category is given an even weighting relative to the other categories*

## ❑ Office Productivity

- Business Winstone™ 2001
  - *Microsoft® Office 2000 (Access, Excel, Frontpage, Powerpoint, Word), Microsoft Project 98, Lotus Notes R5, NicoMak WinZip, Norton AntiVirus, Netscape Communicator*
- SysMark™ 2001, Office Productivity
  - *Microsoft Office 2000 (Access, Excel, Outlook, Powerpoint, Word), Netscape Communicator 6.0, Dragon Naturally Speaking Preferred v.5, WinZip 8.0, McAfee VirusScan 5.13*

## ❑ Digital Media

- Content Creation Winstone® 2001
  - *Adobe Photoshop 5.5, Adobe Premier 5.1, Macromedia Director 8.0, Macromedia Dreamweaver 3.0, Netscape Navigator 4.73, Sonic Foundry Sound Forge 4.5*
- SysMark 2001, Internet Content Creation
  - *Adobe Photoshop 6.0, Adobe Premier 6.0, Macromedia Dreamweaver 4.0, Macromedia Flash 5, Microsoft Windows® Media Encoder 7*

## ❑ 3DGaming

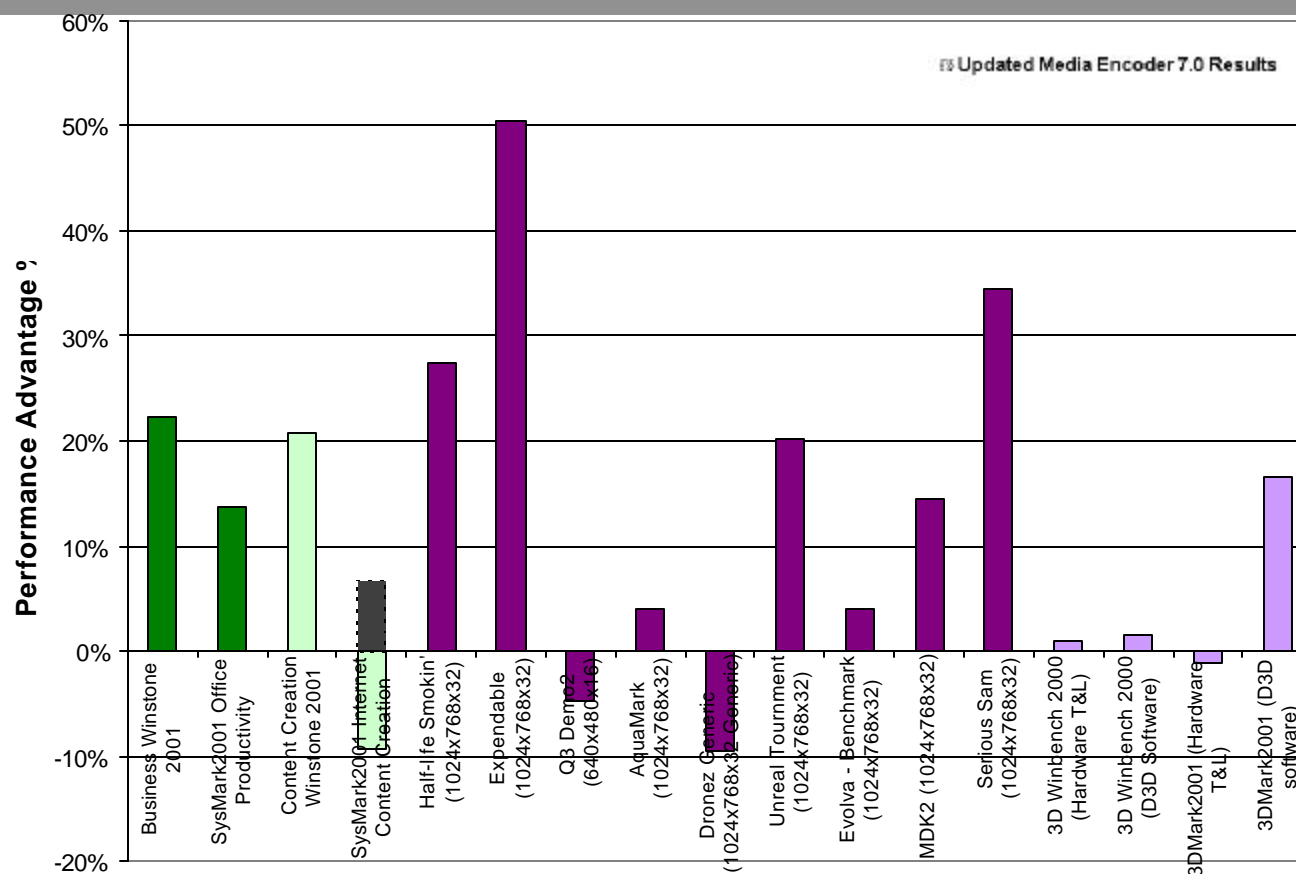
- Game Titles
  - *Half-life Smokin', Expendable, Quake 3, AquaMark, Dronez Generic, Unreal Tournament, Evolva, MDK2*
- 3DMark™ 2001 (Hardware T&L)
- 3DMark™ 2001 (D3D software)

# AMD Athlon™ XP Processor

## Application Performance



AMD Athlon™ XP 1800+ vs. Intel® Pentium® 4 1.8GHz  
Windows® XP



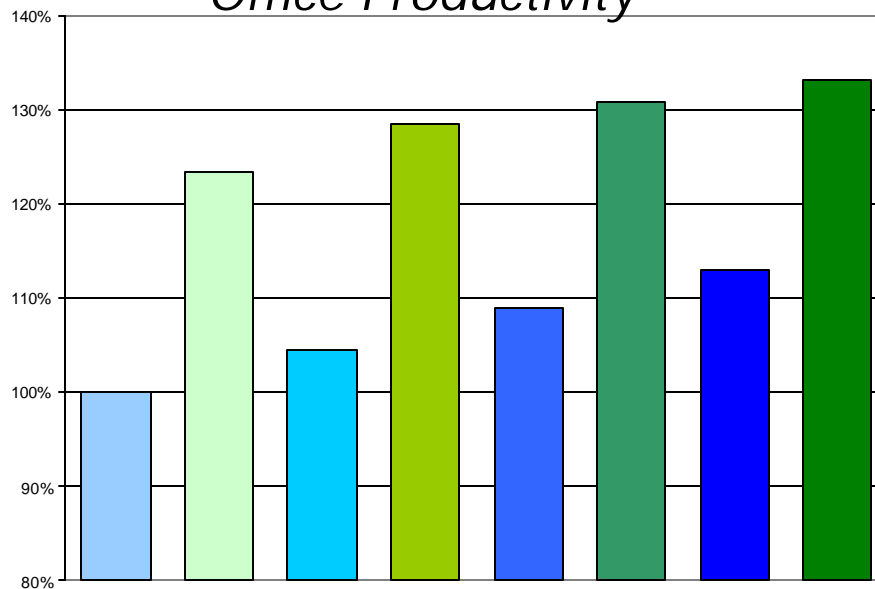
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# AMD Athlon™ XP Processor – SDRAM Application Performance



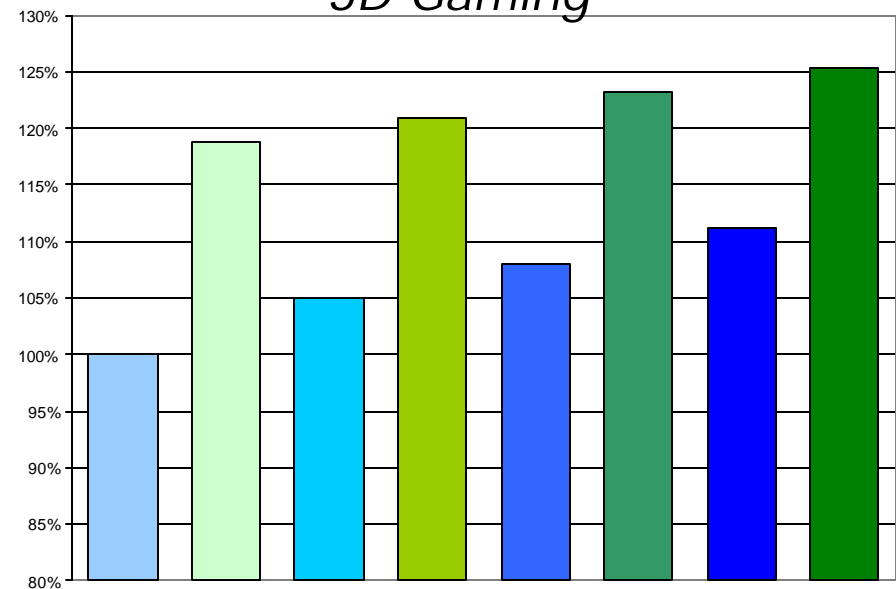
AMD Athlon XP™ 1800+ vs. Intel® Pentium® 4 1.8GHz  
Windows® XP – SDRAM Memory Configuration

## Office Productivity



- AMD Athlon™ XP 1800+
- Pentium® 4 1.8GHz
- AMD Athlon™ XP 1700+
- Pentium® 4 1.7GHz
- AMD Athlon™ XP 1600+
- Pentium® 4 1.6GHz
- AMD Athlon™ XP 1500+
- Pentium® 4 1.5GHz

## 3D Gaming

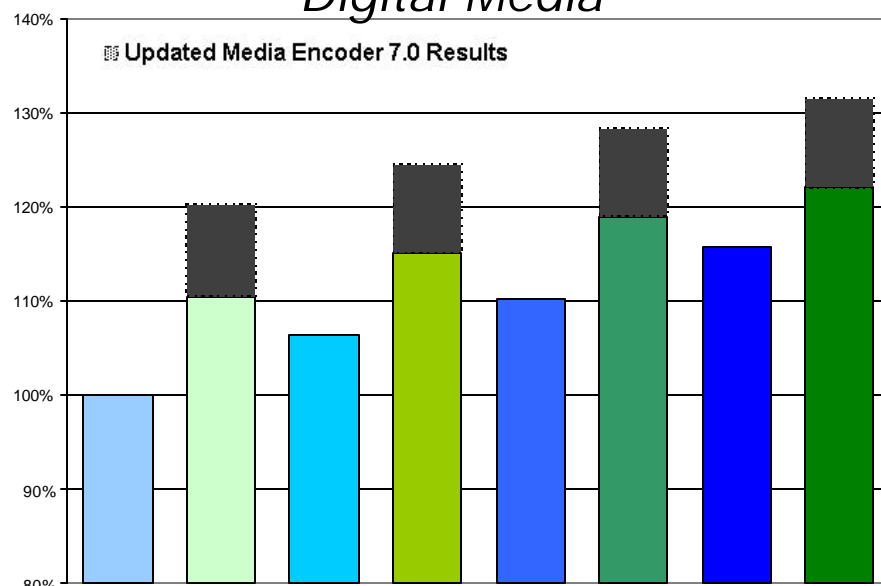


# AMD Athlon™ XP Processor – SDRAM Application Performance



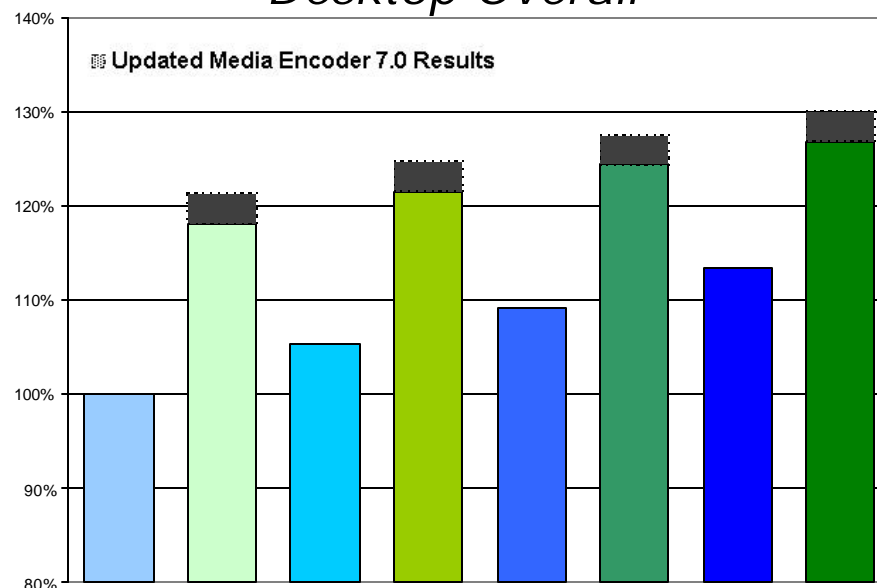
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## Digital Media



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## Desktop Overall



# Driving Platform Innovation



- ❑ AMD and DDR Memory Technology
  - AMD led the charge
  - AMD delivered the first DDR chipset to the marketplace
  - Systems with AMD processors and DDR memory offer superior performance at a fair price
- ❑ AMD is working with several key partners to develop new chipset innovations to drive the performance of the Socket A platform:
  - **VIA - KT266A**
    - *Support for DDR and SDRAM*
  - nVIDIA™ – nForce
    - *Dual Channel DDR*
    - *Integrated GeForce graphics*
  - SiS - 735
    - *Single Chip North Bridge and South Bridge*
  - ALi - MobileMAGiK 1
    - *DDR memory support for mobile platforms*



# Reviews on Pentium® 4 with SDRAM



## ❑ **Xbit Laboratories, September 25, 2001**

- "...nothing encouraging for Intel...In case [of] i845, the reason is the utterly poor performance of the chipset itself. In order to compensate for it, we'll have to take a faster and more pricy CPU."

## ❑ **Ace's Hardware, September 10, 2001**

- "...The 1.33 GHz Athlon mops the floor with the i845 platform as it outperforms a 2GHz Pentium® 4 by 31%..."
- "...no question about it, the limited bandwidth of the i845 platform simply strangles the Pentium 4."

# AMD Athlon™ & AMD Athlon XP Processor

## Benchmark System Configurations - DDR



Operating System	Windows® XP	Microsoft Windows XP Professional RTM, no service packs / updates installed Build# 2600, DirectX version 8.1 (4.08.01.0810)
Hardware	Motherboard	Gigabyte GA-7DX (board rev. 4.0, BIOS rev 7dX F5C)
	Memory	PC2100 (DDR SDRAM) Qty (2) 128MB DIMM Modules (256MB total)
	Hard Drive	IBM 30.7GB UDMA 100 (model DTLA-307030)
	Network Card	Allied Telesyn AT2700TX 10/100
	Sound Card	Sound Blaster Live!
	Video Card	Leadtek Winfast GeForce2 Ultra 64MB DDR
Drivers	AGP Miniport	Publisher Name: Provided by Operating System
	EIDE Drivers	Publisher Name: Provided by Operating System
	Network Card	Publisher Name: Provided by Operating System
	Sound Card	Publisher Name: Provided by Operating System
	Video Card	NVIDIA Version: 5.13.01.1241, Date if applicable: 5/16/2001



# AMD Athlon™ & AMD Athlon XP Processor

## Benchmark System Configurations - SDRAM



Operating System	Windows® XP	Microsoft Windows XP Professional RTM, no service packs / updates installed Build# 2600, DirectX version 8.1 (4.08.01.0810)
Hardware	Motherboard	Asus A7V133 (rev 1.05, BIOS rev 1006 beta 001-i)
	Memory	PC133 (SDRAM) Qty (2) 128MB DIMM Modules (256MB total)
	Hard Drive	IBM 30.7GB UDMA 100 (model DTLA-307030)
	Network Card	Allied Telesyn AT2700TX 10/100
	Sound Card	Sound Blaster Live!
	Video Card	Leadtek Winfast GeForce2 Ultra 64MB DDR
Drivers	AGP Miniport	Publisher Name: Provided by Operating System
	EIDE Drivers	Publisher Name: Provided by Operating System
	Network Card	Publisher Name: Provided by Operating System
	Sound Card	Publisher Name: Provided by Operating System
	Video Card	NVIDIA Version: 5.13.01.1241, Date if applicable: 5/16/2001

# Intel Pentium® 4 Processor

## Benchmark System Configurations - RDRAM



Operating System	Windows® XP	Microsoft Windows XP Professional RTM, no service packs / updates installed Build# 2600, DirectX version 8.1 (4.08.01.0810)
Hardware	Motherboard	Intel D850GB, i850 Chipset, BIOS version GB85010A.86A.0063.P14.017182015
	Memory	PC-800 (RDRAM®), Qty. (2), 128MB RIMM Modules (256MB total)
	Hard Drive	IBM 41.0GB UDMA 100 model(IC35L040AVER07-0)
	Network Card	Allied Telesyn AT2700TX 10/100
	Sound Card	Sound Blaster Live! Model CT4670
	Video Card	Leadtek Winfast GeForce3 64MB DDR
Drivers	AGP Miniport	Publisher Name: Provided by Operating System
	EIDE Drivers	Publisher Name: Provided by Operating System
	Network Card	Publisher Name: Provided by Operating System
	Sound Card	Publisher Name: Provided by Operating System
	Video Card	NVIDIA Version: 5.13.01.1241, Date if applicable: 5/16/2001

# Intel Pentium® 4 Processor

## Benchmark System Configurations - SDRAM



Operating System	Windows® XP	Microsoft Windows XP Professional RTM, no service packs / updates installed Build# 2600, DirectX version 8.1 (4.08.01.0810)
Hardware	Motherboard	Intel D845WN, i845 Chipset, BIOS version HV84510A.86A.0018.P04.0107302001
	Memory	Micron (PC-133 SDRAM) Model: MT16LSDT1664AG-13EC7, PC-133-222 Qty. (2), 128MB DIMM Modules (256MB total)
	Hard Drive	IBM 41.0GB UDMA 100 model(IC35L040AVER07-0)
	Network Card	Allied Telesyn AT2700TX 10/100
	Sound Card	Sound Blaster Live! Model CT4670
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This presentation contains forward-looking statements, which are made pursuant to the safe harbor provisions of the U.S. Private Securities Litigation Reform Act of 1995. Forward-looking statements are generally preceded by words such as “expects”, “plans”, “believes”, “anticipates”, or “intends.” Investors are cautioned that all forward-looking statements in this presentation involve risks and uncertainty that could cause actual results to differ materially from current expectations. Forward-looking statements in this presentation involve the risks that AMD may not successfully produce the AMD Athlon™ XP processor in volumes demanded by the market; that OEM partner systems incorporating the AMD Athlon XP processor may not be released on schedule; that AMD’s efforts to drive an industry-wide initiative to develop a new and more complete PC processor performance metric may be unsuccessful; and that AMD may not use an independent third party to audit the performance benchmarks for the AMD Athlon XP processor. We urge investors to review in detail the risks and uncertainties in the company’s U.S. Securities and Exchange Commission filings, including the most recently filed Form-10K.

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